

# ADVANCED COMMAND AND CONTROL TECHNOLOGIES FOR ENHANCING URBAN OPERATIONS

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## ABSTRACT

This paper will address emerging tactics, techniques, and procedures (TTPs) for Joint urban operations, and provide a vision for the future of battle command (recent Army term for C2). Considering these emerging TTPs, the proposed vision, and the challenges posed by the urban environment, it will identify needed capabilities. A brief discussion of related technology programs, projects, and initiatives will follow. Finally, there is a discussion of some capability gaps that need to be addressed.

## 1. INTRODUCTION

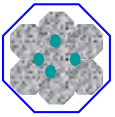
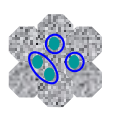


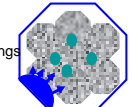
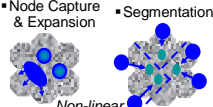
There exists increasing probability that future conflicts will occur in urban environments. In recent decades, the world's urban population has grown significantly. About 47 percent of the world's population lived in urban areas in 2000. Presently, there are 411 cities with over 1 million residents. Most of the urban growth will continue in less developed countries, with as much as 60 percent of the world's population being urban by 2030. (PRB, 2004)

The C2 of military operations has become increasingly difficult with today's fast-moving Joint and coalition forces spread out over large areas. The problem is compounded by complex and urban environments where fighting can become isolated. A commander must think Joint and execute in four dimensions, and overcome difficulties with partial or missing information, compressed time constraints, poor battlespace visualization, and challenges with synchronization of assets and operations. He must control mixed assets (i.e. humans, robots, and sensors). To limit noncombatant casualties and collateral damage, commanders must have greatly improved battlefield awareness, hit avoidance, and more focused combat power. Further, urban operations are compounded by the ease in which units may become separated, radio frequency (RF) communications and

global positioning system signal degradation, human and organizational factors, and the diversity of cultures and languages faced by today's Warfighter.

## 2. EMERGING TTPs

As seen in Figure 1, urban operations TTPs are transforming from painstaking ground assaults with large numbers of forces and excessively destructive remote strikes, to more efficient Joint operations that identify, isolate, and assault nodes with precision weapons and smaller forces. Successful employment of such TTPs will reduce force requirements, civilian casualties and collateral damage, and shorten mission times. Figure 1, lower tier, depicts that C2 will become more complex with concomitant potential for fratricide.

	Past	Emerging
<b>Isolation</b>	<ul style="list-style-type: none"> <li>• Siege</li> <li>• Blockade</li> </ul> <i>Resource Intensive</i> 	<ul style="list-style-type: none"> <li>• Nodal Isolation</li> </ul> <i>Stresses Situational Awareness</i> 
<b>Remote Strike</b>	<ul style="list-style-type: none"> <li>• Massive Destruction</li> </ul> 	<ul style="list-style-type: none"> <li>• Precision Strike</li> </ul> <i>Baghdad</i> 
<b>Ground Assault</b>	<ul style="list-style-type: none"> <li>• Linear movement</li> <li>• Clear buildings and rooms</li> </ul> 	<ul style="list-style-type: none"> <li>• Node Capture &amp; Expansion</li> <li>• Segmentation</li> </ul> <i>Non-linear</i> 

**Figure 1. Emerging urban TTPs**

*NATO Study Report: Urban Operations in the Year 2020, 23 May 2002*

## 3. C2 VISION AND NEEDED CAPABILITIES

New command and control capabilities will be required to execute these transformational TTPs.

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### 3.1 C2 Vision

Commanders will employ network-/execution-centric combined arms forces and joint capabilities at the lowest tactical echelons and with minimal staffs. To do so, commanders will rapidly and effectively synchronize ground and air forces (Joint and/or coalition), command and control systems, plans, effects (from weapons and actions), battlespace information, and logistics support.

### 3.2 Capabilities Needed

This C2 vision is enabled by improvements in:

- Four-dimensional situational understanding in complex and urban terrain
- Ability to visualize, describe, and direct mixed assets
- Reducing decision cycles through information “push/pull”
- The effective exchange of information with Joint and/or combined force C2 systems
- Valid metrics to quantify C2 capability improvement

## 4. CURRENT TECHNOLOGY EFFORTS

There are many DoD-wide technology efforts addressing the above capabilities including the Army’s Future Combat System, C2 CUT STO, Warriors’ Edge, and Fusion Based Knowledge for the Future Force STO.

### 4.1 Future Combat System (FCS)

The FCS is a network-centric, multi-mission combat system that will be overwhelmingly lethal, strategically deployable, self-sustaining, and highly survivable through the use of networked manned and unmanned ground and air platforms, sensors, and weapon systems.

### 4.2 C2 CUT

This Army STO will develop C2 capabilities that provide dismounted and mounted commanders and soldiers with revolutionary information collection/management, planning, and decision aids to support close combat and stability operations in complex and urban terrain. This STO will develop distributed C2 tactical decision aids, applications, and algorithms that address decision making with partial and missing information in complex/urban terrain. This includes the ability to manage dynamic uncertainty, control mixed assets, apply software filtering and agents, fuse and tailor information, and employ environmental algorithms for close combat.

### 4.3 Future Force Warrior (FFW)

The human-centric FFW program is developing a lightweight, overwhelmingly lethal, fully integrated

individual combat system; with modular weapon, head-to-toe individual protection, netted communications and information systems, and soldier worn power sources. A small unit of FFWs will exhibit unsurpassed lethality, survivability, communications, and responsiveness.

### 4.4 Fusion Based Knowledge for the Future Force

This Army STO is developing an advanced knowledge generation and explanation capability to develop an advanced knowledge generation and explanation capability (automated decision-support) for answering war fighting commanders’ critical intelligence requirements in a timely manner.

## 5. CAPABILITY GAPS

The above efforts are being validated through experimentation and potential capability gaps are being identified. For example, needs such as: three-dimensional location within large buildings; 4-D visualization of large, populated urban areas; and enemy nodes identification in stability operations have been recognized. Also, the effective management of information relative to the commander’s critical information requirements must be determined as well as the ability to balance command with control during urban combat and stability operations – i.e., increased control may dictate reduced command. Further, the need to provide for C2 of mixed assets without cognitively overloading the soldier is a challenge which must be met as well as valid metrics to quantify improvements in military C2 taking into account its manifold constituent systems and human variables..

## 6. CONCLUSIONS

The inevitability of increased urban operations and emerging TTPs necessitate revolutionary C2 decision-making technologies for the dismounted soldier and commander that enable rapid situational understanding and the control of mixed assets from Joint and coalition sources with relative ease. Accurately measuring C2 capability improvements is a critical aspect of focusing efforts to increase the survivability and lethality of Warfighters engaged in urban operations.

## REFERENCES

- Population Reference Bureau (PRB), [http://www.prb.org/Content/NavigationMenu/PRB/Educators/Human\\_Population/Urbanization2/Patterns\\_of\\_World\\_Urbanization1.htm](http://www.prb.org/Content/NavigationMenu/PRB/Educators/Human_Population/Urbanization2/Patterns_of_World_Urbanization1.htm), 2004
- Urban Operations in the Year 2020, NATO Study Report, 23 May 2002